Real-Time Iot Air Quality Analysis Using Arduino

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Abstract

The pollution level in our environment grows as countries become more industrialized, presenting a major hazard to all living organisms. Pollution levels increase rapidly as a result of factors such as industry, urbanization, population growth, and car use, all of which impair human health. Air pollution is the most serious environmental problem, causing a variety of human ailments and contributing to global warming. To prevent the negative imbalance in nature, a pollution monitoring system is essential. This model tracks the pollutant PM2.5 in the air, which people may readily inhale and let to enter our lungs and bloodstream, causing major health concerns. We proposed design includes a hardware module, such as a dust sensor, and software architecture for remotely monitoring pollution data through a single web-based graphical application that may be utilized in industrial regions and traffic areas to monitor air quality levels. Furthermore, air pollutant information should be presented in public locations so that everyone is aware of the pollutants levels around them.

Keywords: Arduino, Dust Sensor, Air Quality, IOT, WIFI-Module

1. INTRODUCTION

Air pollution is a serious problem, and instances have occurred all around the world. Poor air quality, in particular, may endanger people's respiratory health. Numerous studies have shown that exposure to chemical components such as particulate matter puts people at an increased risk of developing a variety of ailments. Furthermore, many people today choose to spend their time inside rather than outside. Most people spend around 90% of their time inside [1]. Indoor air is more polluted than outside air, which can be naturally cleaned.

According to the EPA, indoor air pollutants may be 2 to 5 times more toxic than outside air pollutants, and in certain cases more than 100 times more toxic [2]. [4]. Indoor air pollution disproportionately affects children and the elderly. The Internet of Things (IoT) is a network configuration in which people may move data over a network without necessitating a two-way shake-over between humans, i.e., from the source to the destination or between people and their computers. The Internet of Items extends online properties into numerous gadgets and common objects, which allow embedded instruments to interact and interrelate with the external world through the internet, in addition to traditional devices such as desktops, mobile computers, and smartphones. The Internet of Objects seeks to provide "Ubiquity," which allows anything to be linked to anything and by anybody at any time through any path/network and any service [1]. The properties of the Internet of Things, such as an ultra-large network of things, device and network heterogeneity, and many unanticipated events, will make developing multiple applications and services exceedingly difficult. Middleware often helps the development process by unifying disparate computer and communications devices and enabling interoperability across multiple applications and services. [4]. Obtaining air quality information may protect individuals from the health effects of air pollution [5]. The amount of data generated by environmental sensors has increased considerably as IoT has evolved. Using this data, governments and local stakeholders strive to conduct anti-air pollution actions [7]. Because air quality is impacted by multiple elements such as temporal and geographical air dispersion, it is difficult to anticipate and analyse. Outdoor air quality may be influenced by air pollution sources, weather conditions, and transportation movement. Outside air conditions have an impact on the air, but so do tenant behavior, living patterns, and ventilation practises. As a consequence, the factors influencing indoor air analysis must be extensively examined. Analyzing air data produced by environmental sensors has been extensively investigated in order to develop air quality control techniques. It is produced as a byproduct of human activity such as the use of fossil fuels in automobiles, power plants, cooling systems, and other industrial processes. Many sources of outdoor particles may contribute to air pollution. Some of the research investigated the sources of indoor air pollution. The propensity and effect characteristics of indoor PM2.5 variation were investigated [10].

2. BACKGROUND STUDY

V. Choudhary and colleagues [1] The AirQ platform was a low-cost real-time and location-based air quality monitoring device. Sensor calibration is so helpful that the AirQ can deliver air quality data that is appropriately connected to the NEA air quality station for a fraction of the cost. As a result, the AirQ platform may be used to create huge, high-density air quality monitoring networks for Smart Cities.

Dissanayaka, A. D., et al. [2] provide a comprehensive approach for determining air quality, forecasting pollution levels at each place, and recommending the optimum route for travel with the least polluted air. Every minute, the air quality monitoring device detects carbon monoxide and gas concentrations in each zone and transmits this sensor data to the database in the form of a data packet including two concentration values and the device's terminal number. It was smaller, less expensive, simpler to maintain, portable, and could be repaired anywhere.

K. Gao and colleagues [3] Effective monitoring and forecasting of quality have revealed significant environmental challenges. It employs web-text analysis to aid parameters in detecting all relevant material and developing an optimal quality and parameter collecting structure.

R. Grace et al. [5] To monitor air pollution, each place needs monitoring and analysis of air pollution. When air quality equipment were deployed, environmental quality was easily assessed, and pollution was rapidly regulated. The air quality equipment must be connected so that measured and processed data may be sent to users over the internet. Sensors detect the presence of pollutants in the air, and sensor data is processed using fuzzy c-means clustering algorithms to increase accuracy. The proposed research and visualisation of air quality in industrial and heavily polluted areas has been expanded.

A. Kumar et al. [6] A low-cost air quality monitoring system has been proposed to detect and notify persons when the amount of these components in real-time exceeds a particular limit and to display data in various parameters, such as smoke, carbon monoxide, and particulate matter, in an easily understandable way (PM). To extend the system, more sensor nodes may be added in the future. The key advantage of this system was that it was portable, small, and affordable. The proposed system employs 'ThingSpeak' to display data visually and supports contemporary technologies like as Nodes, Rubies, and others. The authors of this paper discussed the creation of a low-cost IoT-based air quality monitoring system. Aside from being less expensive and consuming less power, it takes up less room, can be placed anywhere, and provides more efficiency and flexibility than traditional wired systems.

J. Son and Y.-S. Son [8] The authors use IoT to analyse the interior environment, as well as the concentration and correlation coefficient of air quality by season and place. Indoor air quality was worse in the spring than in the winter, and the placement of the office hall was worse than the entrance and window. Nonetheless, the average indoor air quality score was lower than the WHO standard. Indoor air quality is abnormally low due to the spring air conditioning test, and the average result is below the typical threshold. Fine and ultrafine dust is positively associated to spring temperature and negatively connected to CO_2.

Su, Y. [9] estimates Beijing's air quality using the gradient addition approach. From 2010 to 2016, the gradient improvement framework was used to build on all of the models that projected PM2.5 concentric based on environmental parameters like as temperature and wind speed in Beijing. Light GBM outperformed XGBoost in terms of performance, according to testing data. There were only 50,000 data points in this study. Light GBM's bucket-splitting strategy will significantly decrease machine learning in real-world huge data processing as data size grows.

Yu, C [11] The authors collected daily air quality data from the Wuhan environment from January 2013 to May 2016. Using the exploratory analysis approach, the authors aim to discover trends and hidden patterns. First, the scientists used daily air quality data to examine air pollution trends and main contaminants. Following that, the authors discovered a plethora of intriguing tendencies depending on different temporal granularities, such as season, month, and week. Finally, the authors use linked analyses to try to explain the influence of human activities on ambient air quality.

3. SYSTEM MODEL

The major goal of this research is to create a mechanism for detecting contaminants in the air. An Arduino Uno, a WIFI module, and a DUST sensor were used to build the suggested system. This air quality detection and monitoring system provides real-time data through PCs and mobile devices. Figure 1 depicts a schematic block diagram of the proposed system.

3.1 ARDUINO

Arduino is a prototyping platform built on simple hardware and software. It consists of a programmable circuit board (a microcontroller) and ready-made software known as the Arduino IDE, which is used to develop and upload computer code to the physical board.

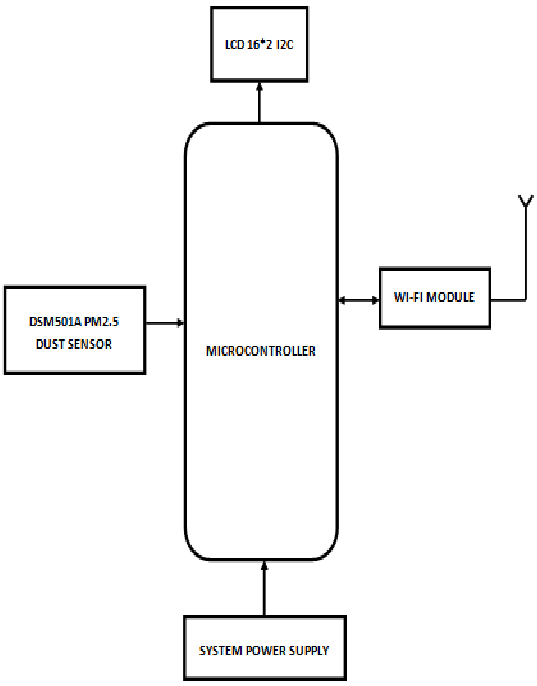

Figure 1: Block Diagram for the proposed model

Figure 1 represents the block diagram for dust sensor with PM 2.5 with the wifi module.

3.2 LIQUID CRYSTAL DISPLAY (LCD)

LCDs use materials with fluid and crystal characteristics. Instead of having a melting point, the molecules are almost as mobile as a liquid within a temperature range, but they are separated into a crystal-like structure. The LCD is made up of two glass panels with fluid crystal material embedded in sand. Clear electrodes are applied to the inside surface of the glass panels to indicate the character, symbols, or patterns. Polymer layers between

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electrodes and liquid crystal maintain a consistent angle of the fluid crystal molecules. Each polarisation is linked to one of the two glass panes on the exterior. This would cause light beams to rotate at a fixed angle in a certain direction. When the LCD is turned off, the two polarise and the crystal fluid twist light beams, releasing them from the LCD; the LCD is transparent.

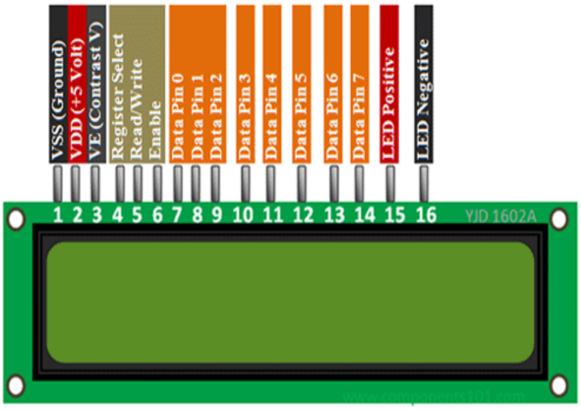

Figure 2: LCD Display

The LCD Display is represented at figure 2 and it indicates the number with descriptions. Figure 3 represents the block diagram for power supply unit.

3.3 POWER SUPPLY

For electronic equipment or products, a trustworthy power supply unit (PSU) is required. Almost all household gadgets, such as televisions, printers, and music players, have an inbuilt power supply system that converts AC Network voltage to the proper DC level for them to function. The most common power supply circuit is the SMPS (Switching Mode Power Supply). It converts the alternating current power source to 12 volt direct current. The system takes a 12V supply from the Arduino Uno and converts it into two 5V outputs using the IC7805 voltage regulators and filters. A 5V supply is used to power the DUST SENSOR, WIFI MODULE, and LCD 16*2.

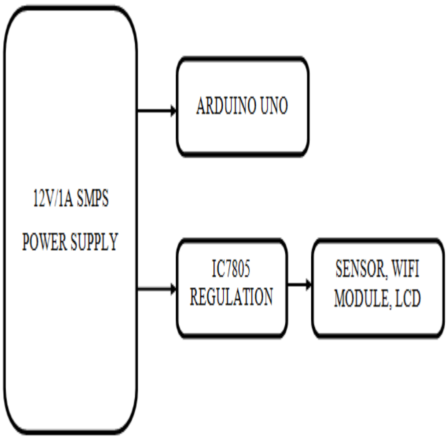

Figure 3: Block diagram for Power Supply

3.4 FIXED VOLTAGE REGULATORS

Voltage regulators include a type of integrated circuits (ICs). Regulator IC is frequently used. A circuitry reference source, amplifier and control units, and load protection are all included in the devices. Everything in an IC unit modifies either a fixed positive voltage, a fixed negative voltage, or an adjustable set stress. The regulators may be configured to work with load currents ranging from millennia to tens of amps, corresponding to power rates ranging from milliwatts to tens of watts. Unregulated dc input voltage regulator; Vi applied on the input terminal, dc output voltage controlled, Vo on the second terminal, and a third terminal connected to ground.

3.5 ESP8266 - WI-FI MODULE

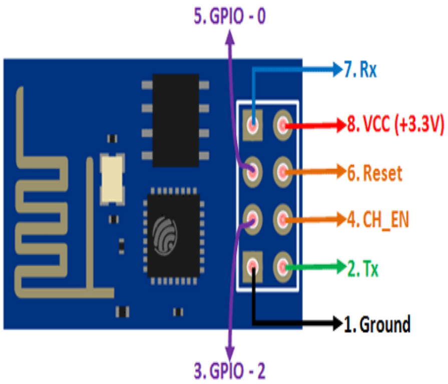

Figure 4: WI-FI-Module

The ESP8266 Wi-Fi is a stand-alone SOC system with an integrated TCP/IP protocol stack that allows any microcontroller to connect to a Wi-Fi network. The ESP8266 may run an app or get complete Wi-Fi connectivity from another CPU. Each ESP8266 module is pre-programmed by a firmware AT command set to connect to your Arduino device and Wi-Fi as much as a Wi-Fi Shield. Figure 4 depicts the ESP8266, a reasonably inexpensive board with a growing community.

This module has robust onboard processing and storage capacity for integrating sensors and other application-specific devices through its GPIOs, with low-up programming and little loading during operation. Its high chip integration allows for little additional circuitry on a small PCB, including the front-end module. With VoIP and Bluetooth connections, the ESP8266 enables APSD. It can operate in all operational circumstances and does not need any additional RF components.

3.6 DUST SENSOR

DSM501A Dust sensor Module detects the size of dust by sensing the adjustable resistance of tobacco smoke and pollen, household dust, such as automatic heating suction equipment.

Figure 5 depicts the detection of the absolute number of particles per unit volume using the same particle counter idea as the base.

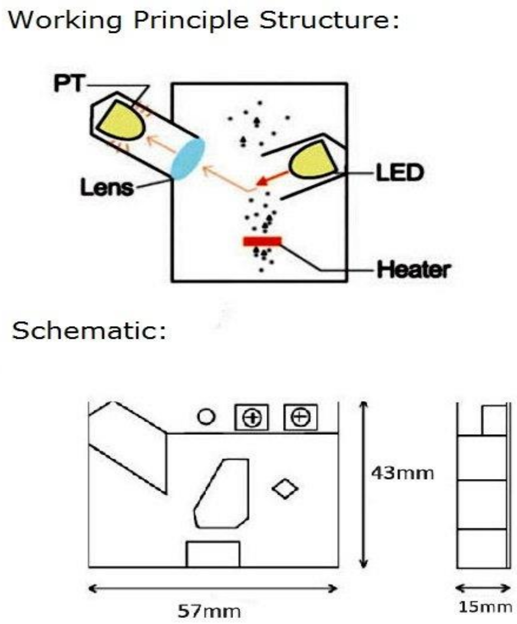

Figure 5: Dust Sensor Working principle

4. RESULTS AND DISCUSSION

According to a recent Human Development Report, air pollution kills approximately 2.7 million people globally each year, with 90 percent dying in underdeveloped nations [12]. Smoke is created by air pollution in homes, and harmful gases such as carbon dioxide (CO2) are produced by charcoal, cow dung, and wood used for heating and cooking. These are often utilised in rural areas. Vehicles and industrial units are quickly expanding, generating comparable pollution problems in less developed countries. Furthermore, automobile pollution is becoming a severe problem since car emissions directly harm people on the roads. Schoolchildren in Indian cities are especially vulnerable to air pollution because they are in close contact with dangerous particles on the roads. As a result, people suffer breathing problems, insomnia, and other symptoms.

The correlation analysis was used in this research to assess the link between indoor and outdoor air quality. The condition of air variables in each room was compared to the outside environment. The actual value of each data point has been scaled in order to reduce volatility in the data distribution and compare the data flow of each station. As a result, the time variable had little effect on the correlation value in any sector. However, some areas are linked, while others are not. Air quality is susceptible to changes in some spaces, while external forces have no impact in others. As a result, we can conclude that each indoor characteristic, such as the occupants' behaviour and space features, has a significant impact on the correlation value.

Dust's effects on agriculture and the environment are determined by particle size, deposition rate, and air concentration. The effects of particulate matter (PM) on flora and wildlife vary depending on the PM component. Plant growth, total yield, and reproduction are all hampered by PM10 dust. Certain emissions, such as those with a greenhouse effect, may potentially contribute to climate change [13]. With expanding technology and rapid industrialisation to suit the needs of growing populations, dust air pollution and its influence on human health have become a serious worldwide concern.

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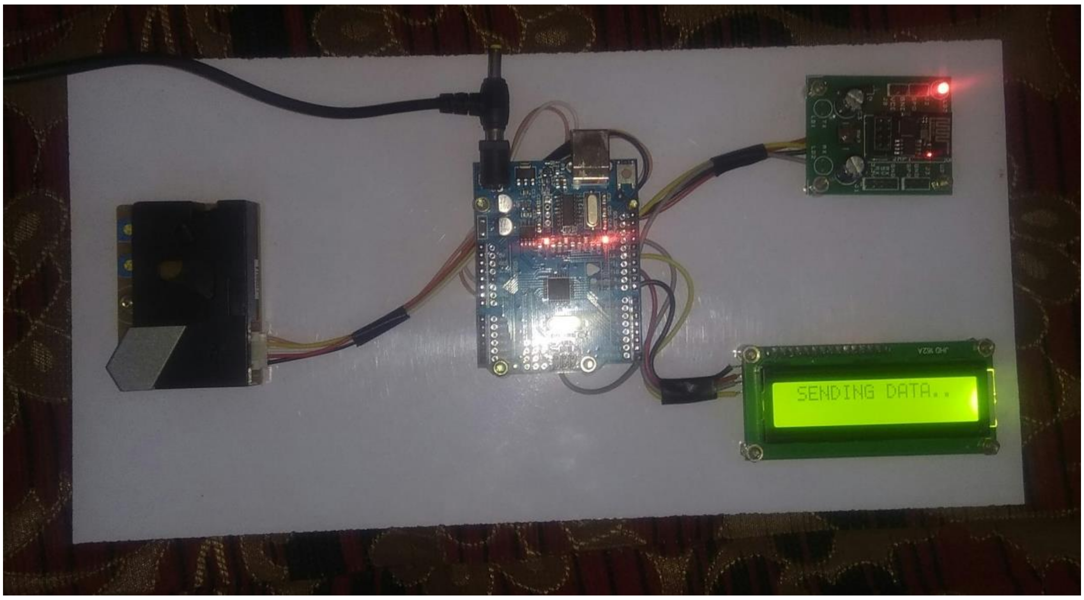

Figure 6: Data is transmitted to the system

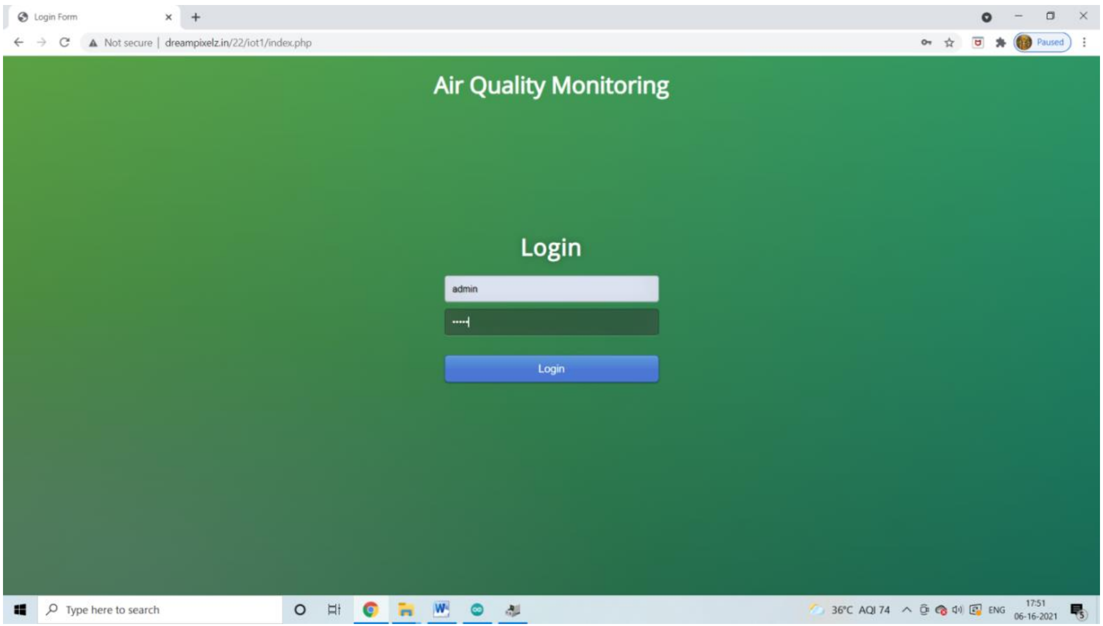

Figure 7: Air Quality monitoring Output Screen Shot using Web View

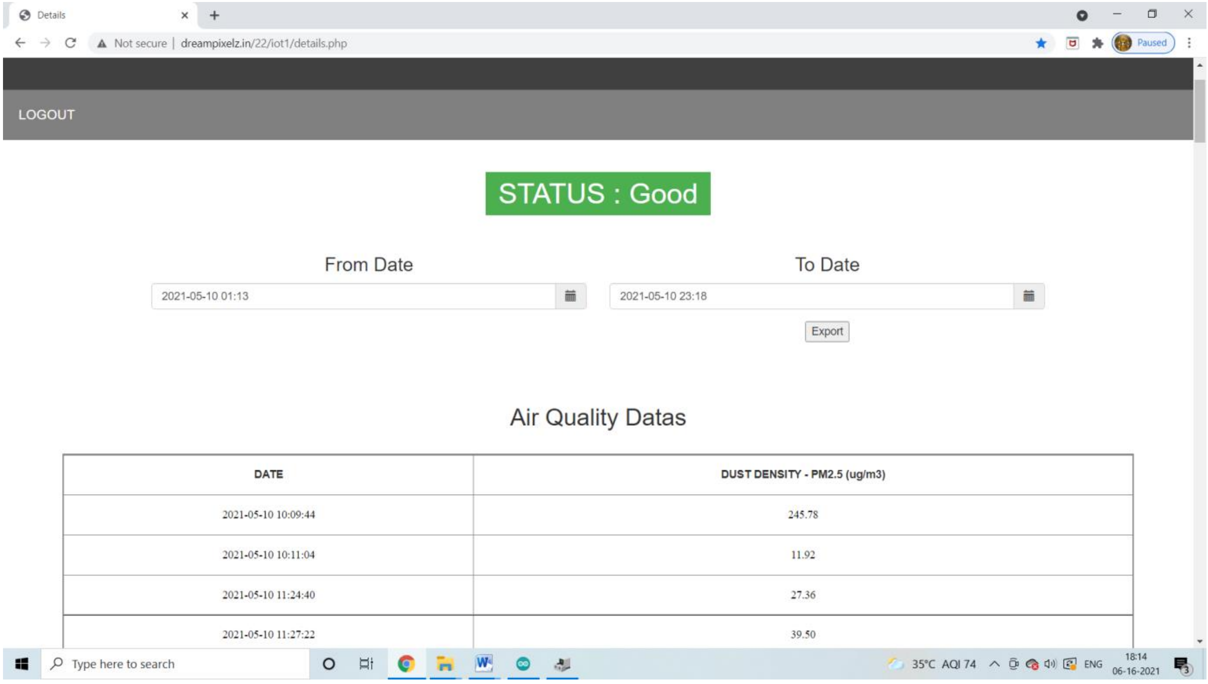

Figure 8: Air Quality Data for PM2.5

Figure 6, 7, 8 represents the output result. Figure 6 illustrates the hardware part like ardunio board, LCD and sensor details also. Figure 7 represnets the air quality monitoring website. The received output data's are stored and it is displayed in figure 8.

People are aware of the environmental damage caused by rising industrialisation. SPM levels rose, resulting in over 4,000 deaths. Because it is released near people, indoor air pollution is extremely hazardous to health. A contaminant emitted inside is thought to be many times more likely to enter the lungs than one released outside. A significant portion of the population in developing countries relies on biomass for energy. Wood, charcoal, agriculture leftovers, and animal dung are examples of these. Open fires are often utilised in rural and urban homes for cooking and heating. The burner is commonly left on the floor, increasing the risk of accidents and poor cleanliness.

Furthermore, they often lack a chimney to remove pollutants. Children and women are more likely to be affected in such homes since they spend more time at home. The main pollutant in this environment is SPM. Indoor air pollution, particularly particulate matter, is one of the leading causes of death in India's rural areas. Many children are killed by acute respiratory infections; others are killed by cardiovascular diseases, lung cancer, and persistent breathing issues in adults. Household use of coal and biomass may have a negative influence on indoor air quality if emissions are high and ventilation is poor.

5. CONCLUSION

Because of the fast expansion of the businesses that are the principal producers of pollutants, pollution is becoming a big concern for the population's health. The Wireless Sensor Network is used in this air quality monitoring and detection approach to monitor air quality in multiple areas, providing data that can be accessed in near real-time through web-enabled sites. Air pollutants should be exhibited in public locations so that everyone is aware of the concentration of pollutants around them. This discovery allows individuals, especially those with preexisting underlying health concerns, to monitor the air they breathe. Different sensors may be used to collect additional data. Future improvements to this device may include increased system resilience, sensor data accuracy, and device size.

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